International Journal of Computer Networking,
Wireless and Mobile Communications (IJCNWMC)
ISSN(P): 2250-1568; ISSN(E): 2278-9448
Vol. 3, Issue 5, Dec 2013, 41-48

IMPROVED CLUSTERING PROTOCOL FOR DELAY MINIMIZATION

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ABSTRACT

Energy in wireless sensor network is the curious resource. Energy efficient routing protocol is need in the wireless sensor network. Clustering is the routing protocol, which is energy efficient than other routing protocol like direct diffusion, MTE, PEGASIS etc. Currently clustering technique is subdivided into two phases, setup phase and steady state phase. In setup phase cluster head is selected on the basis of different parameter like random number, remaining energy, distance to base station etc and cluster formation takes place. In the steady state phase sensor node sense the surrounding environment and report sense data to cluster head, where cluster head aggregate sense data and send to the base station. Setup phase takes much time than steady state phase in a round that is treated as the delay in data reporting. We propose improved clustering protocol in which setup phase and steady state phase will be overlapped and take less time in a round. Simulation result shows that the proposed protocol complete one round in less time than tradition clustering protocol.

KEYWORDS: Setup Phase, Round, Time, Delay, Energy

1. INTRODUCTION

Wireless Sensor Network (WSN) is the network of tiny sensors limited to processing power, radio range and energy. WSN also consist a base station treated as the sink, where each sensor node (source node) report the sense data. The nodes are used for sensing and monitoring physical or environmental conditions such as temperature, pressure, vibration, humidity, sound etc. The information sensing node is known as source node and information gathering node is considered as sink node. The nodes are working together to monitor region. The sensed information moves from the source node to sink node with the help of intermediate nodes.

The WSNs may be used in a variety of everyday life activities or services. For example a common application of WSNs is for monitoring. In the area of monitoring, the WSN is deployed over a region in order to monitor some phenomenon. A practical use of such a network could be a military use of sensors to detect enemy intrusion. In case that the sensors detect an event (change on heat or on the blood pressure) then the event is immediately reported to the base station, which decides the appropriate action (send a message on the internet or to a satellite). A similar area of use may be the monitoring of the air pollution, where the WSNs are deployed in several cities to monitor the concentration of dangerous gases for citizens. Moreover, a WSN may be used for forest fires detection to control when a fire has started. The node will be equipped with sensors to control temperature, humidity and gases which are produced by fire in the trees or vegetation. In addition to the above, an important area of use is the natural hazards like earthquake, tsunami, cyclone etc. This area the WSNs may enable new functionalities that will assist to manage the problems occurred by these hazards but

it requires information without long delay. These hazards may occur in long time so a energy efficient WSN is needed that will pertain for long time. In WSN 60% amount of energy is conserve in communication. We need to choose a appropriate routing technique for such type of applications. Routing algorithms can be widely classified into two categories. They are direct routing and indirect routing. In direct routing algorithms [2], [3] each nodes in WSNs directly forward the gathered data to the sink node. Contrarily, indirect routing algorithms [4], [5] are those clustering algorithm that creates different clusters of sensor nodes in WSNs. Clustering is suggested to WSNs due to its advantages of energy saving, network scalability and network topology stability [4]–[6]. Furthermore, clustering technique decreases the overheads occurred due to communication, thereby reducing interferences and energy consumptions among network nodes. In addition, clustering improves the efficiency of data relaying by decreasing number of nodes required to forward data in the WSNs, using data aggregation at CHs by intra cluster communication decreases overall packet loses. However, clustering algorithms have some disadvantages compared to other mechanisms, such as additional overheads during cluster head selection, cluster formation, and assignment process.

In conventional clustering, the nodes in WSNs are divided into small groups called clusters. The clustering protocols consist setup phase and steady state phase [3]. In setup phase cluster head selection and cluster formation process is accomplished. Many clustering protocols follow threshold based cluster head selection. This takes very less time (in milliseconds) to decide the node is cluster head or non cluster head node but is takes long time to form the clusters by sending request message and wait for reply. In this paper we propose a new improved clustering protocol for delay minimization in which we overlap the setup phase and steady state phase. The simulation shows that the proposed protocol is better in delay minimization for data reporting.

The remainder of the paper is organized as follows. In Section 2, we continue with related work. In Section 3, we propose the new scheme ICP. Section 4 shows the performance of the proposed scheme and we provide conclusions in Section 5.

2. RELATED WORK

Many different approaches have been carried out to design feasible WSNs. Energy conservation is crucial to the prolong the network lifetime of WSNs. The large amount of energy consumed in routing data to base station. Many approaches for energy efficient routing have been proposed to reduce energy consumption. One alternative approach to conserve energy is using clustering technique [7]. In addition, when scalability is considered to be a major problem when network density is of hundreds and thousands of nodes then clustering is considered to be a useful technique. In various WSNs applications routing efficiency is considered important for energy efficiency, load balancing, and data fusion [8]. In this paper we are concern about time delay in cluster head selection and cluster formation schemes and discuss some of the associated schemes. In clustering, only CHs need to communicate with the sink node via multihop communication. Low Energy Adaptive Clustering Hierarchy [3] is a well known clustering algorithm in which the cluster head in cluster is periodically rotated among members to achieve energy balance. However, this scheme showed only partial success, it needs a new cluster formation process at every section which is very time consuming. With cluster formation, in each cluster with random probability a new cluster head node is re-elected, and from the promising cluster head candidates, the optimal node should be adaptively optimized for minimum communication distances to the maximum number of one hop neighbors. This only produce worst suboptimal solution due to cluster re-election process, which results in the nodes to spend additional delay and energy. In addition, LEACH requires all CHs to perform single hop transmissions to the networks sink, thus it suffers from the cost of long-range transmissions. As a result, the CHs that are further away from the sink depletes their energy much earlier than others. In EARACM [9] selects some overhearing nodes

as cluster head nodes. This scheme adopted the multi-hop transmission to further minimize the energy absorption. Unfortunately, this benefit comes from sacrificing the resulting transmission delay and communication overhead since each cluster head node has to maintain the status of the other cluster head nodes. In EECS [10], during cluster formation it allocates only less number of nodes to the clusters with longer distances to the sink node.

In brief, total time delay and energy consumption in multihop data delivery in clustered WSNs should be analyzed comprehensively. Such an analysis should be based on an clustering protocol and energy-efficient data routing that prevent using network-wide broadcasts and reduces additional overhead. Furthermore, to affirm the time delay in a WSNs, this trade-off between the distance to the sink from source and the cluster size should be studied analytically, before setting up the network hierarchy.

3. PROPOSED APPROACH

There are many clustering protocols proposed for energy efficiency, but most of the approaches cannot be focus on the delay between data sensing to data reporting. Therefore a distributed approach is required for clustering that should be energy efficient and data reporting at the base station is very fast. In this paper a new clustering protocol has been proposed to decrease the delay for data reporting and it optimize the energy consumption in clusters communication.

Improved Clustering Protocol

The clustering process in this proposed protocol has been accomplish in one phase where as exiting cluster protocols are accomplish in two phases setup phase and steady state phase. For the development of ICP, we made some assumptions about the sensor nodes and the underlying network model. For the sensor nodes, we assume that all sensor nodes can transmit with enough power to reach the BS if needed, that the nodes can use power control to vary the amount of transmit power, and that each sensor node has the computational power to support best MAC protocols that will have least number of collision.

In ICP, the sensor nodes organize themselves into local clusters, with one sensor node acting as the cluster head. All non-cluster head nodes transmit their data to the cluster head, while the cluster head node receives data from all the cluster members, performs data aggregation, and transmits aggregated data to the base station. Therefore, being a cluster head node is much more energy intensive than being a noncluster head node. If the cluster heads were chosen a priori and fixed throughout the system lifetime, these nodes would quickly use up their limited energy. Once the cluster head runs out of energy, it is no longer operational, and all the nodes that belong to the cluster lose communication ability. Thus, ICP incorporates randomized rotation of cluster head position among the sensor nodes to avoid draining the energy of any one sensor node in the network. In this way, the energy load of being a cluster head is evenly distributed among the sensor nodes.

Clustering Process in ICP

Once the sensor nodes have elected themselves to be cluster heads using the probabilities in used in LEACH []. At the end of cluster head election each sensor node start sensing environment parameters and the cluster head nodes must let all the other nodes in the network know that they have chosen this role for the current round. To do this, each cluster head node broadcasts a cluster formation message (CLUF) using a nonpersistent carrier-sense multiple access (CSMA) MAC protocol [11]. This message is a small message containing the sensor node's ID and a header that distinguishes this message as an announcement message. Each non-cluster head node determines its cluster for this round by choosing the cluster head that requires the minimum communication energy, based on the received signal strength of the cluster

formation message from each cluster head. Assuming symmetric propagation channels for pure signal strength, the cluster head cluster formation message heard with the largest signal strength is the cluster head that requires the minimum amount of transmit energy to communicate with. Note that typically this will be the cluster head closest to the sensor, unless there is an obstacle impeding communication. In the case of ties, a random cluster head is chosen. After each node has decided to which cluster it belongs, it must inform the cluster head node that it will be a member of the cluster. Each non cluster head sensor node transmits a join-request message (Join-REQ) with sense data back to the chosen cluster head using a nonpersistent CSMA MAC protocol. This message consisting of the node's ID, the cluster head's ID and sense data. We assume that the nodes are all time synchronized and start the setup phase at the same time. This could be achieved, for example, by having the BS send out synchronization pulses to the nodes. Once the cluster head receives all the data from cluster members, it performs data aggregation to enhance the common signal and reduce the uncorrelated noise among the signals. The resultant data are sent from the cluster head to the BS. Since the BS may be far away and the data messages are large, this is a high-energy transmission. The preceding discussion describes communication within a cluster, where the MAC and routing protocols are designed to ensure low energy dissipation in the nodes and no collisions of data messages within a cluster.

4. SIMULATION AND ANALYSIS

In this section we evaluate the performance of Improved Clustering Protocol (ICP). At first, ICP will be executed for different number of sensor nodes in sensing field. Each node is capable to select itself as a cluster head; it will intimate its status to the nearer nodes by sending cluster formation message. Cluster head is responsible for gathering information from its cluster member nodes. Now, the cluster member nodes will send a message to its cluster head containing its join and sensed data. Similar process will takes place in each cluster. In Second ICP will be executed for number of cluster members in the cluster, it can be expressed like number of cluster head in sensing field.

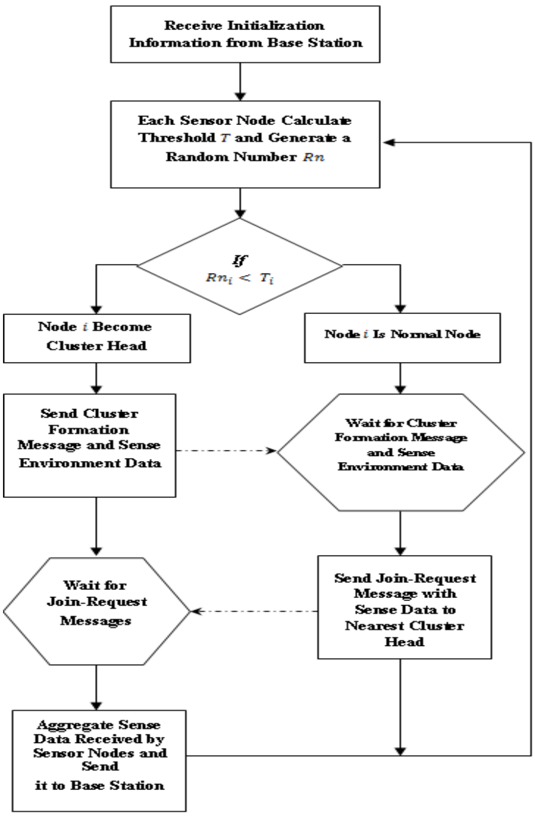

Figure 1: Flow Chart Of ICP

We simulate a clustered wireless sensor network in a field with $100x100\ m^2$ dimension. The total number of sensor nodes varies in field. The sensor nodes are randomly distributed over the sensing field. This mean that vertical coordinate of each sensor nodes are randomly selected between 0 and maximum value of dimension. The base station is outside the sensing field. The initial energy of a sensor node is set to 0.5J. The parameters uses in this simulation are summarized in table 1 show in below.

Table 1: Simulation Parameter

Parameter	Value
Network size	$(100 \times 100\ m^2)$
Number of sensor node (n)	$100$to 500
Base station position	$(500\ m, 100\ m)$
Initial energy	$0.5J$
Transmitter/Receiver electronics E_{elec}	$50\ nj/bit$
Data aggregation (E_{DA})	$5\ nj/bit/report$
Reference distance (d_0)	$87\ m$
Transmit amplifier ϵ_{fs}	$10\ pJ/bit/m2$
Transmit amplifier ϵ_{mp}	$0.0013\ pJ/bit/m4$
Message size (l)	$4000\ bits$
Data size	500 bytes
Bit rate	$1\ Mbps$
Radio propagation speed	$3 \times 10^8\ m/s$
Processing delay	$50\mu s$
Radio speed	$1\ Mbps$
TDMA frame time	$80ms$
Data aggregation time	$10ms$

Number of Sensor Nodes in Sensing Field

In this ICP performance has been observed by varying sensor nodes in sensing field. We observed that by increasing the sensor nodes in sensing field time delay is also increases but the time delay of ICP is better than the traditional clustering protocol as shown in figure 2.

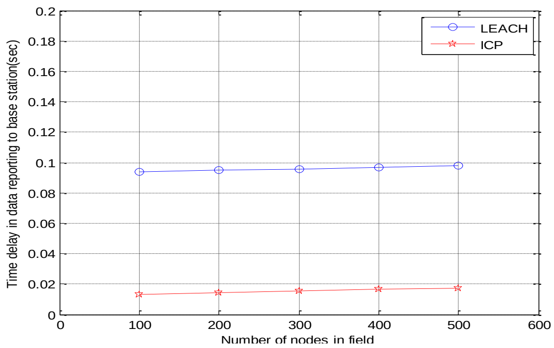

Figure 2: Comparative Graph of ICP and LEACH Protocol on the Basis of Sensor Nodes

Number of Cluster Members in Sensing Field

In this the performance of ICP has been observed by varying cluster members in sensing field. To increase the cluster heads in sensing field will decreases cluster members per cluster. We observed that by decreasing cluster members

per cluster time delay is also decreases (not much interval) but the time delay of ICP is better than the traditional clustering protocol as shown in figure 3.

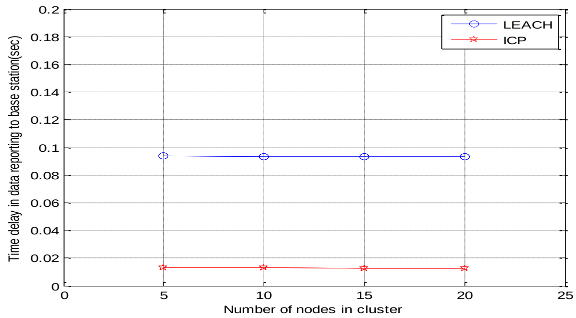

Figure 3: Comparative Graph of ICP and LEACH Protocol on the Basis of Cluster Members

5. CONCLUSIONS

We examined the need of clustering in Wireless Sensor Network. We introduced improved clustering protocol. In ICP protocol message communication reduces in setup phase that decreases time for cluster formation. The overlapping of setup and steady state phase is also considered which also decrease the time delay from data sensing to data reporting at base station. The simulation result shows that the ICP protocol has lower delay in data reporting than tradition clustering protocol. In future ICP protocol will consider for mobile network and energy efficiency can also be achieve through ICP.

REFERENCES

1. Akyildiz, I. F., Su, W., Sankarasubramaniam, Y., & Cayirci, E. (2002). Wireless sensor networks: a survey. Computer networks, 38(4), 393-422.

2. Sidhik, A. K., Feng, W., & Elmirghani, J. M. (2009). Energy-Efficient Geographic Routing in Ad-hoc Wireless Networks. In *London Communications Symposium*.

3. Heinzelman, W. R., Chandrakasan, A., & Balakrishnan, H. (2000, January). Energy-efficient communication protocol for wireless microsensor networks. In System Sciences, 2000. Proceedings of the 33rd Annual Hawaii International Conference on (pp. 10-pp). IEEE.

4. Yin, B., Shi, H., & Shang, Y. (2007, February). Analysis of energy consumption in clustered wireless sensor networks. In Wireless Pervasive Computing, 2007. ISWPC'07. 2nd International Symposium on. IEEE.

5. Chan, H., & Perrig, A. (2004). ACE: An emergent algorithm for highly uniform cluster formation. In Wireless Sensor Networks (pp. 154-171). Springer Berlin Heidelberg.

6. Manjeshwar, A., & Agrawal, D. P. (2002, April). APTEEN: A Hybrid Protocol for Efficient Routing and Comprehensive Information Retrieval in Wireless Sensor Networks. In ipdps (Vol. 2, p. 48).

7. Al-Karaki, J. N., & Kamal, A. E. (2004). Routing techniques in wireless sensor networks: a survey. Wireless Communications, IEEE, 11(6), 6-28.

8. Intanagonwiwat, C., Govindan, R., Estrin, D., Heidemann, J., & Silva, F. (2003). Directed diffusion for wireless sensor networking. Networking, IEEE/ACM Transactions on, 11(1), 2-16.

9. Yi, S., Park, G., Heo, J., Hong, J., Jeon, G., & Cho, Y. (2005). Energy aware routing based on adaptive clustering mechanism for wireless sensor networks. In Networking and Mobile Computing (pp. 1115-1124). Springer Berlin Heidelberg.

10. Ye, M., Li, C., Chen, G., & Wu, J. (2005, April). EECS: an energy efficient clustering scheme in wireless sensor networks. In Performance, Computing, and Communications Conference, 2005. IPCCC 2005. 24th IEEE International (pp. 535-540). IEEE.

11. Pahlavan, Kaveh, and Allen H. Levesque.(2005) Wireless information networks. Vol. 93. Wiley. Com.